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(56) Documents Cited
EP 0908292 A1 US 5229043 A
WPI Abstract Accession No. 1997-507612 &
JP 9239819 A (JAPAN) 16.09.1997 (see abstract)
WPI Abstract Accession No. 1997-358471 &
JP 9150449 A (SHOWA) 10.06.1997 (see abstract)

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INT CL[7] B29C 49/00 49/58 49/60 49/62 49/64 49/66
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(54) Abstract Title
Liquid cooled blow moulded article

(57) A method of blow moulding a plastic article is disclosed. The plastic article (38) is blow moulded within a mould (12,14). The article has a plastic parison wall (22). The wall (22) is pierced by a first needle (32) and a second needle (34) or blowing pin. A fluid-tight connection is formed between the first needle (32) and the parison wall (22). A volume of cooling liquid (36) is injected into the article (38) through the first needle (32). The cooling liquid (36) cools the interior wall. Gas is vented from within the article through the second needle (34) while the cooling liquid (36) is injected into the article. The cooling liquid (36) is evacuated through the first needle (32) after the interior wall is cooled sufficiently to be removed from the mould (12,14).

The plastic parison is extruded into the mould.

The cooling liquid may be drained by gravity or positive air pressure.

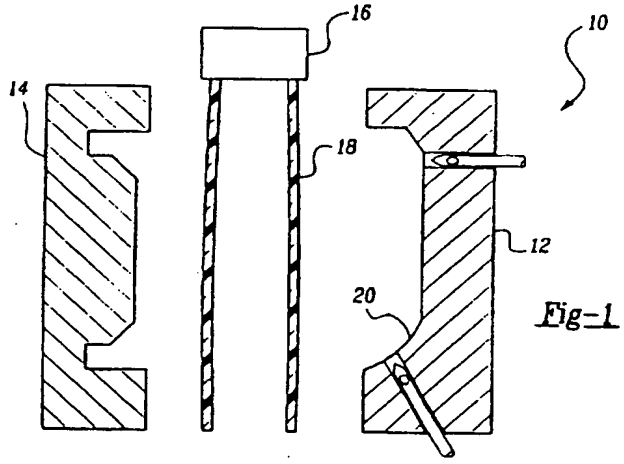

Fig-1

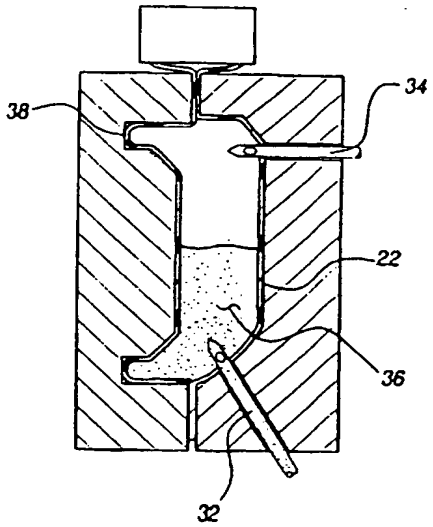

Fig-3

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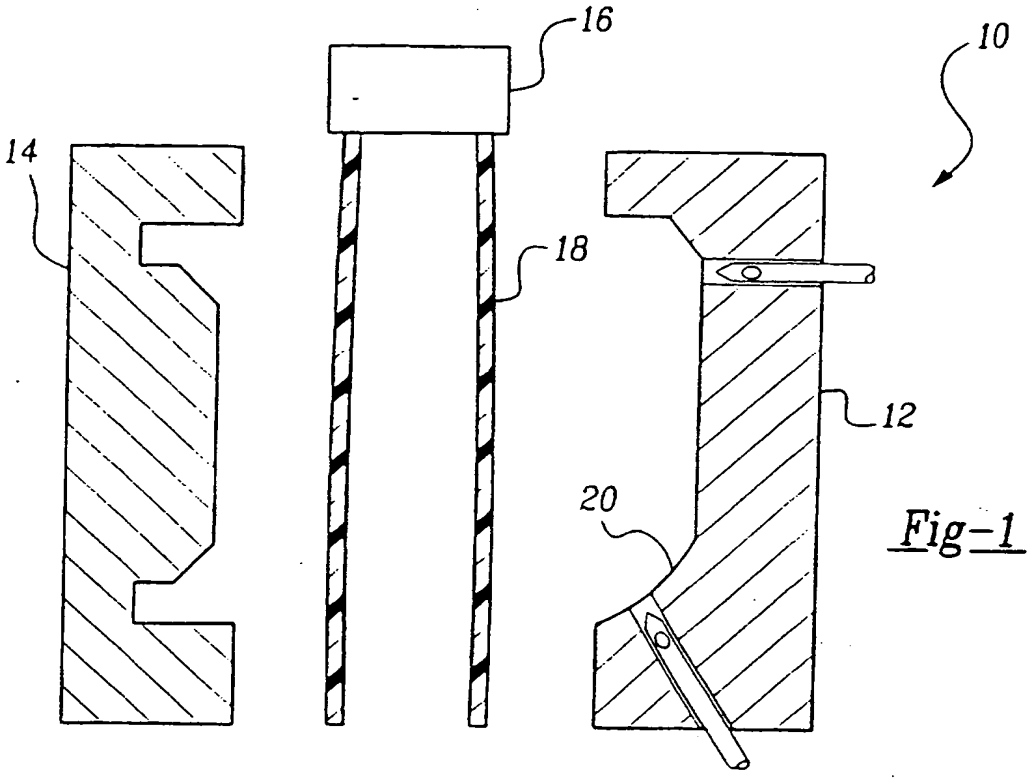

Fig-1

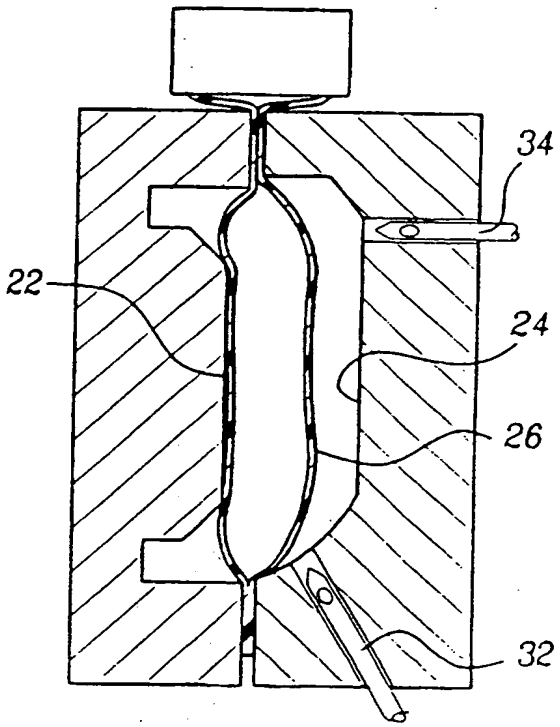

Fig-2

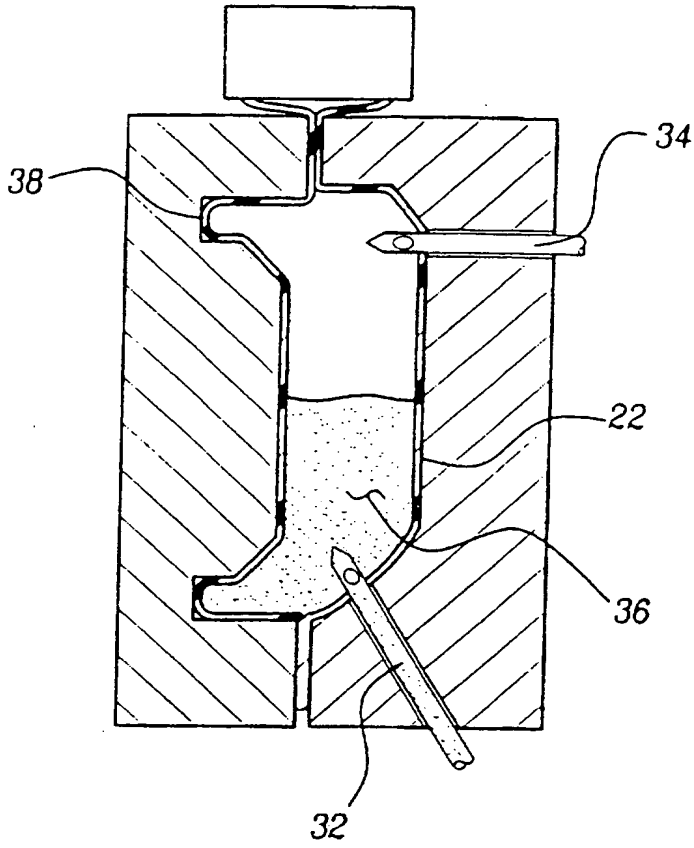

Fig-3

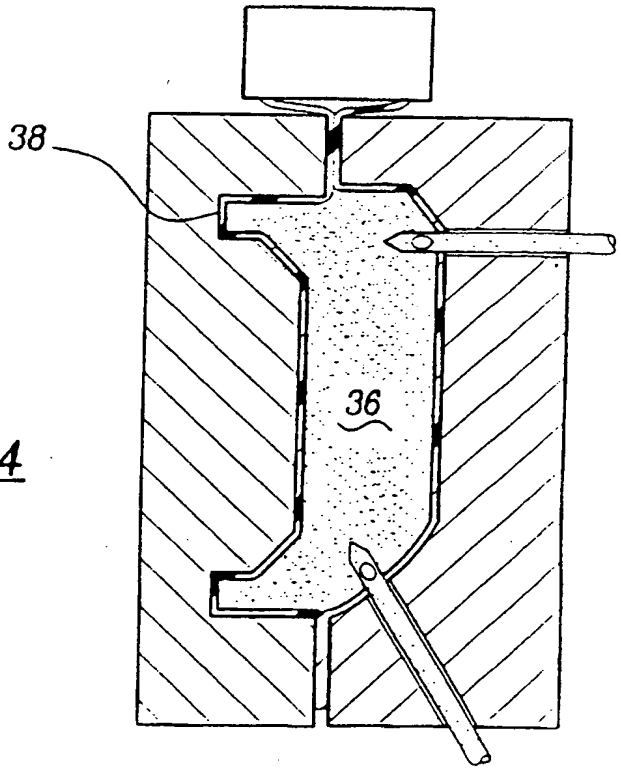

Fig-4

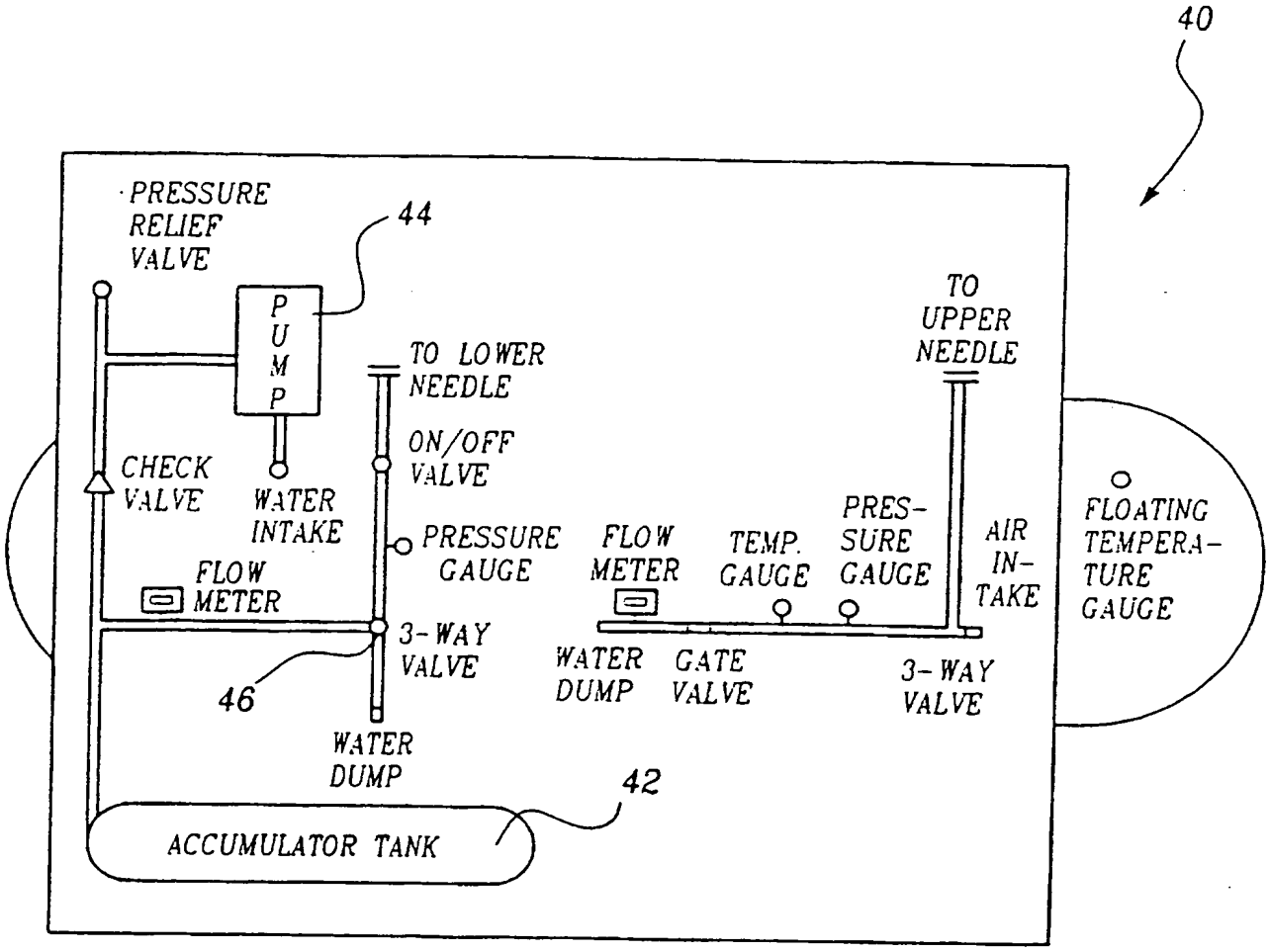
40
PRESSURE RELIEF VALVE
44
PUMP
TO LOWER NEEDLE
TO UPPER NEEDLE
ON/OFF VALVE
CHECK VALVE
WATER INTAKE
PRESSURE GAUGE
FLOW METER
FLOW METER
TEMP. GAUGE
PRES-SURE GAUGE
AIR IN-TAKE
FLOATING TEMPERA-TURE GAUGE
3-WAY VALVE
46
WATER DUMP
GATE VALVE
3-WAY VALVE
WATER DUMP
42
ACCUMULATOR TANK

Fig-5

LIQUID COOLED BLOW MOULDED ARTICLE

The present invention is directed to a method of cooling blow moulded plastic articles by injecting a liquid into the interior of the freshly moulded article. More specifically, the invention relates to a method of blow moulding an article and subsequently cooling the moulded article by injecting a liquid into the interior portion of the article and then applying a positive gas pressure to remove the liquid from the interior of the article.

U.S. Patent No. 3,937,610 ('610) teaches a method of cooling the interior of a blow moulded article with a liquid mist. The '610 patent is directed to a method for reducing the cycle time of moulding a blown article by reducing the time needed to cool the article before it can be removed from the mould. After the article is blown, small globules of liquid are circulated through the interior of the article. The liquid evaporates when it contacts the hot plastic wall, thus reducing the temperature of the blown article. Air is circulated within the article to evaporate any remaining liquid. A volume of cooling liquid is not circulated within the interior of the article. Only small liquid globules suspended within the mist contact the article walls. While the method described in the '610 patent reduces the time needed to cool the article, the cycle time reduction is not as great as in the present invention. The liquid globules suspended within the mist do not have sufficient capacity to rapidly cool thick-walled blow moulded articles when compared to a solid liquid medium.

Two additional references which also teach including liquid within the blowing medium are U.S. Patent No. 5,498,390 and Japanese Patent Application No. 05-023094. These references similarly require that the cooling liquid be suspended within the blowing medium and evaporate upon contact with the hot parison walls. While this method of manufacturing blow moulded articles reduces the cycle time

when compared with ambient cooling, it does not provide the rapid cooling of the present invention due to the superior ability of liquid water to remove heat energy.

Japanese Patent Application No. 50-104616 ('616) teaches a method of making a container by blow moulding. After the container has been blow moulded, a cooling liquid is introduced into the interior of the moulded article. This is known as "water casting" where a quantity of cooling liquid equal to the volume of the container is introduced and held within the article. The amount of heat removed from the article is limited by the volume of water. In the present invention, the cooling liquid is circulated through the article and more than the container volume of cooling liquid may be circulated through the article to remove more heat. The present invention also introduces a constant "in-out" flow of water, creating turbulence. Turbulent flow inside the article provides the greater thermal cooling.

The '616 patent application teaches a method of moulding a container around a blowing mandrel. The parison seals between the outer perimeter of the water inlet and the mould to form a fluid-tight seal. Sealing between the parison and the water inlet system has been a key impediment for using liquid cooling for blow moulding. Most mould applications do not support the use of a mandrel between the mould walls. In these applications, needle or pin is used to pierce the parison and inject cooling liquid into the moulded article. Forming a fluid-tight seal between the parison and the needle is necessary to implement liquid cooling.

The present invention is directed to a method of blow moulding a plastic article. A plastic article is blow moulded within a mould. The article has a plastic parison wall. The wall is pierced by a first and a second needle or blowing pin. The wall forms a fluid-tight connection between the first needle and the parison wall. A volume of cooling liquid is injected into the article through the first needle. The cooling liquid cools the interior wall.

Gas is vented from within the article through the second needle while the cooling liquid is injected into the article. The cooling liquid is evacuated through the first needle after the interior wall is cooled sufficiently to be removed from the mould.

The invention enables the rapid manufacture of blow moulded articles by reducing the dwell time needed within the cavity for the moulded article to solidify. The liquid cooling removes heat from the blow moulded article faster than cryogenic gases, such as nitrogen or carbon dioxide, and faster than an evaporative mist. The invention enables the use of liquid cooling for articles that cannot be manufactured by placing a water inlet between the mould halves. The use of a blowing pin or needle enables the placement of the water inlet and outlet in the uppermost part location which is often not at the mould parting surface. The needles pierce the parison and form a fluid-tight seal between the needle and the article wall to prevent the cooling liquid or evacuation gas from leaking into the mould.

A combination of valves, pump and accumulator enables the cooling liquid to be quickly flooded into the interior portion of the article and removed by pressurised gas. The first needle is placed at a location that easily enables all of the water within the article to be drained. This usually places the first needle at the lowest portion of the mould. A positive air pressure is introduced through the second needle to force out all of the cooling liquid. The article is removed from the mould with little or no remaining cooling liquid therein.

The present invention is useful for applications where it is not feasible to place a stationary water inlet between the mould halves.

The invention will now be described further, by way of example, with reference to the accompanying drawings, in which:

Figures 1-4 illustrate cross-sectional views of a blow moulding apparatus used in the present invention; and

Figure 5 is a schematic view of the control system that operates the cooling steps.

The present invention will be described through a series of drawings, which illustrate the blow moulding method claimed. The drawings illustrate a two-piece blow moulding apparatus moulding an automotive bumper. Other articles may be manufactured using the same or similar equipment and are included within the invention described herein.

The following elements are a word list of the items described in the drawings and are reproduced to aid in understanding the invention.

10	blow moulding apparatus
12,14	moulds
16	extruder
18	parison
20	mould surface
22	parison wall
24	interior surface
26	exterior surface
32	first needle
34	second needle
36	cooling liquid
38	moulded article
40	controller
42	accumulator tank
44	pump
46	three-way valve

Illustrated in Figure 1 is a blow moulding apparatus 10. The apparatus 10 includes two opposed mould halves 12, 14. An extruder 16 is positioned between the moulds 12, 14 and extrudes a pliable parison 18. The parison 18 may be made from a single or multi-layer extrusion. The invention

is particularly well suited for thick walled parisons that have long cooling cycle times. The moulds 12, 14 are closed as illustrated in Figure 2. The closed moulds 12, 14 define an interior mould surface 20.

The parison 18 is inflated and conforms to the mould surface 20. The parison 18 includes a parison wall 22. The parison 18 may be inflated through a gas inlet within the extruder 16, or more preferably through the gas needles as will be more fully described below. The parison wall 22 has an interior surface 24 that faces the interior of the parison 18, and an exterior surface 26 that contacts the mould surface 20.

When moulding relatively thick blow moulded articles, the parison wall 22 is between 2mm and 20mm thick, depending on the application. The parison wall 22 is heated to the given material processing temperature (approx 380°F for HDPE) and may require 4 to 7 minutes to solidify sufficiently to be removed from the mould under normal cooling processes. To decrease the cycle time of the blow moulding apparatus 10, the hot parison wall 22 is cooled, as will be described in Figures 3 and 4.

After the parison wall 22 has been fully extruded and the moulds 12, 14 closed, a small quantify of air partially inflates the parison 18. A first needle 32 is positioned to slide transversely within the mould 12. The first blowing needle 32 is moved from a retracted position to an extended position. In the extended position, the needle pierces the parison wall 22. A quantity of inflation air is injected through the first needle 32 to cause the parison 18 to conform to the shape of the mould surface 20. The first needle 32 generally pierces the parison wall 22 at the lowermost location of the article to assist in draining the cooling liquid. The lowermost location is selected to enable all of the cooling liquid to drain from within the article. The mould configuration may be rotated so that the lower most location positions the article to have an area that is suitable to accept the blow needle aperture. If the

lower most location will become an exposed or visible area of the finished article, then the first needle 32 may pierce a different area of the article that is not the lower most area and use the positive pressure evacuation process described below to drain the cooling liquid.

A second needle 34 generally pierces the parison wall 22 at a uppermost location. The second needle 34 also moves from a retracted to an extended position to pierce the parison wall 22. The first needle 32 is positioned to pierce an area of the article that can accept the blowing needle aperture. The inventors found that sealing between the parison, blowing needles and mould wall is needed to successfully implement the liquid cooling method claimed. The previous attempts of using liquid cooling were unsuccessful because the cooling liquid was able to escape from within the article.

The present invention uses the pliable parison 18 to seal between the mould surface 10, needles 32, 34 and the interior of the moulded article. The needles are described in commonly assigned US patent application, Attorney Docket Number 199-0194, titled: "BLOW MOLDING NEEDLE FOR LIQUID COOLING", filed on an even date herewith, and incorporated herein by reference. The needles compress a quantity to of parison material between the needles and mould to form a fluid tight seal therebetween.

The first and second needles 32, 34 pierce the parison wall 22. A cooling liquid 36 is injected through the first needle 32. The cooling liquid 36 fills the interior of the parison wall 22. The cooling liquid 36 rapidly removes heat from the parison wall 22 and causes the parison 18 to solidify into the moulded article 38. As the cooling liquid 36 fills the moulded article 38, air trapped within the article 38 is expelled through the first needle 32.

The cooling liquid 36 is circulated through the article 38 until the article has cooled sufficiently to be removed from the moulds 12, 14. If very rapid cooling is needed or if very thick-walled articles are moulded, the cooling

liquid 36 may be continually recirculated through the article. The cooling liquid 36 may be circulated through the article 38 and out the second needle 30. This enables very large quantities of cooling liquid to be circulated through the article. Many times more cooling liquid may be circulated than the article volume. By using a cooling liquid in place of cryogenic cooling, cycle time reductions of over 50% compared to previous cycles were achieved.

After the article 38 has cooled sufficiently to be removed from the moulds 12, 14, the cooling liquid 36 is removed from within the article. Based on the article and mould geometry, the cooling liquid may be drained by gravity or positive air pressure through the first needle 32. Because the first needle 32 is positioned at the lowermost portion of the parison wall 32, all of the cooling liquid 36 drains through the first needle 32. The positive pressure can expel the remaining quantify of liquid and also act and an evaporative medium to dry the interior of the article 38. The first and second needles 32, 34 are retracted and the article 38 is removed from the moulding apparatus 10.

The cooling liquid may be water. Additionally, other cooling liquids such as alcohols that have a vapour pressure lower than water and evaporate quickly may be used to provide a dry, residue free article.

The moulding apparatus 10 is controlled through a controller 40. The controller 40 includes an accumulator tank 42 that contains a quantity of cooling liquid in excess of the article volume. A pump 44 pressurises the accumulator with cooling liquid. A valve 46 operated by a PLC controller (not shown) opens to inject cooling liquid to needle 32. Cooling liquid expelled through the second needle 34 enters the controller 40 through a three-way valve 46. If the cooling liquid is water, then the excess cooling liquid is generally flushed down a drain. If the cooling liquid contains expensive non-wetting agents or other items, it may be recirculated through pump 44 through additional valves (not shown). If appropriate liquid pressure is

achieved otherwise, the use of an accumulator may not be necessary.

CLAIMS

1. A method of blow-moulding a plastic article comprising the steps of:

blow-moulding a plastic article (38) within a mould (12,14), said plastic article having an interior parison wall (22);

penetrating said wall (22) with a first needle (32) and a second needle (34), said wall (22) forming a fluid tight seal between said first needle (32) and said mould (12,14);

injecting a volume of cooling liquid (36) into the interior of said article through said first needle (32), said cooling liquid (36) cooling said wall (22);

venting gas from within said article through said second needle (34) while said cooling liquid (36) is injected into said article (38); and

evacuating said cooling liquid (36) from said first needle (32) after said wall (22) has cooled sufficiently to be removed from said mould.

2. A method as claimed in claim 1, further comprising the step of injecting a quantity of gas through said second needle to aid in evacuating said cooling liquid through said first needle.

3. A method as claimed in claim 1, wherein said gas is under pressure and pushes said liquid through said first needle.

4. A method as claimed in claim 1, wherein said article has a top and a bottom with the bottom located at the lower most portion of the article while said article is in said mould and said first needle pierces the bottom of said article.

5. A method as claimed in claim 4, wherein said top is at the upper most portion of said article when said article is in said mould and said second needle pierces said top.

6. A method as claimed in claim 1, wherein said cooling liquid is water.

7. A method as claimed in claim 1, wherein said cooling liquid contains a non-wetting agent.

8. A method as claimed in claim 1, wherein said first needle is moved from a retracted position to an extended position to pierce said wall.

9. A method as claimed in claim 1, wherein said second needle is moved from a retracted position to an extended position to pierce said wall.

10. A method as claimed in claim 1, wherein said cooling liquid is circulated through said article and out of said second needle whereby a volume of cooling liquid in excess of the article volume cools the article.

11. A method of blow-moulding a plastic article comprising the steps of:

extruding a plastic parison within a mould, said parison having an interior and an exterior wall;

partially inflating said parison to form an article having a top and a bottom with the bottom located at the lower most portion of the article while said article is in said mould, and with the top located at the top most portion of the article while said article is in said mould;

moving a first needle from a retracted to an extended position to pierce said bottom with a first needle;

moving a second needle from a retracted to an extended position to pierce said top with said second needle;

injecting a volume of cooling liquid in excess of the volume of the article to cause said cooling liquid to circulate through said article and out of said second needle, said cooling liquid cooling said wall;

venting gas from within said article through said second needle while said cooling liquid is injected into said article;

injecting a quantity of gas through said second needle; and

evacuating said cooling liquid under pressure through said first needle after said wall has cooled sufficiently to be removed from said mould.

12. A method as claimed in claim 13, wherein said cooling liquid is water.

13. A method as claimed in claim 13, wherein said first and second needles are moved from the extended position to the retracted position to remove the article from said mould.

14. A method of blow moulding a plastic article substantially as hereinbefore described with reference to the accompanying drawings.

Application No: GB 0009118.1
Claims searched: 1-14
Examiner: Monty Siddique
Date of search: 31 October 2000

Patents Act 1977
Search Report under Section 17

Databases searched:

UK Patent Office collections, including GB, EP, WO & US patent specifications, in:

UK Cl (Ed.R): B5A (AD25, AD28, AD29, AT15A, AT15B, AT15C, AT15F, AT15P)

Int Cl (Ed.7): B29C 49/00 49/58 49/60 49/62 49/64 49/66

Other: Online: WPI EPODOC JAPIO

Documents considered to be relevant:

Category	Identity of document and relevant passage		Relevant to claims
Y	EP 0908292 A1	(TADA) melt-extruded parison pierced by needles 33, 35, capable of being used in the manner suggested in claims 1 and 11	1, 11 at least
Y	US 5229043	(THE BOC GROUP) cryogenic cooling liquid used	1, 11 at least
X	WPI Abstract Accession No. 1997-507612 & JP 9239819 A (JAPAN POLYOLEFINS) 16.09.1997 (see abstract)		1, 11 at least
X	WPI Abstract Accession No. 1997-358471 & JP 9150449 A (SHOWA) 10.06.1997 (see abstract)		1, 11 at least

X Document indicating lack of novelty or inventive step
Y Document indicating lack of inventive step if combined with one or more other documents of same category.
& Member of the same patent family
A Document indicating technological background and/or state of the art.
P Document published on or after the declared priority date but before the filing date of this invention.
E Patent document published on or after, but with priority date earlier than, the filing date of this application.